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Fluid intelligence, emotional intelligence, and the Iowa Gambling Task in children

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ABSTRACT

This study explored the roles of fluid intelligence and emotional intelligence (EI) in predicting performance on the Iowa Gambling Task (IGT) in intellectually average and gifted children. One hundred and twenty-five average children and ninety-eight gifted children were tested with Cattell's Culture Fair Intelligence Test, the Trait Emotional Intelligence Questionnaire-Child Form and the IGT. It was currently found that intellectually gifted children demonstrated better IGT performance than their average peers, including superior decision-making strategies, decision-making speeds and conceptual knowledge stages in the IGT. Fluid intelligence and emotional intelligence played different roles in predicting IGT performance in average and gifted children: average children's IGT performance was related to fluid intelligence and EI, whereas gifted children's IGT performance was associated only with fluid intelligence. IGT performance was more strongly associated with cognitive processes compared to emotional processes. The present study helps to explain how cognitive and emotional processes interact in intellectually average and gifted children's decision making.

1. Introduction

Executive function (EF) is essential for children's goal-directed behaviors and self-regulation, and EF can be divided into two forms based on motivational significance: cool EF (more abstract tasks) and hot EF (emotionally significant tasks) (Zelazo & Cunningham, 2007). Research has found that intellectually gifted individuals demonstrate better performance in executive function (EF) tasks (Duan, Wei, Wang, & Shi, 2010; Schweizer & Moosbrugger, 2004), however, these studies focused mainly on "cool" EF, and fewer studies have focused on the relationship between IQ and hot EF. Therefore, it is still unknown whether intellectually gifted children would have better performance compared to intellectually average children of the same age on hot EF tasks.

The Iowa Gambling Task (IGT) has been widely used to assess hot EF (Prencipe et al., 2011), which is designed to simulate real-life decision-making situations by setting the uncertainty of monetary rewards and punishments (Bechara, Damasio, Damasio, & Anderson, 1994; Bechara, Damasio, Damasio, & Lee, 1999). One main characteristic of this task is that participants must reject short-term profit in favor of long-term benefits (Dunn, Dalgleish, & Lawrence, 2006). The IGT paradigm involves two advantageous decks and two disadvantageous decks. The net scores are used to assess an individual's performance on IGT, which are calculated by subtracting the total number of disadvantageous deck decisions from total advantageous choices. In addition to the net scores, participants' accounts of how they conceptualize the IGT and of the strategies they used are also recorded. A brief interview with two questions is conducted after participants complete the IGT (Crone & van der Molen, 2004): (i) "Which deck did you prefer?" (ii) "Tell me why you preferred that deck." Participant's response can be categorized into one of four conceptual knowledge stages as defined in Crone and van der Molen (2004): (1) incorrect preference (preference for disadvantageous decks), (2) don't know (lack of understanding regarding what the task is about), (3) hunch phase (a feeling that the disadvantageous decks are riskier than the advantageous decks), and (4) conceptual knowledge phase (knowing the reason why certain decks are disadvantageous over the long run).

Recently, a substantial number of studies have begun to focus on the relationship between fluid intelligence and IGT. Theoretically, Busemeyer and Townsend (1993) believe that inductive reasoning ability (fluid intelligence) is involved in IGT, and participants need to speculate on the probabilities of reward and punishment based on their

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past choices from the four decks. Empirically, most existing studies have concentrated on adult samples, and only a few studies have examined whether fluid intelligence can predict IGT performance in children. Studies with adults samples, both healthy and clinical samples, have found that fluid intelligence can predict IGT performance (e.g., Demaree, Burns, & DeDonno, 2010; Fein, McGillivray, & Finn, 2007; Haaland & Landrø, 2007; Johnson, Yechiam, Murphy, Queller, & Stout, 2006; Levine et al., 2005; Nakamura et al., 2008; Webb, DelDonno, & Killgore, 2014). However, the existing research showed that fluid intelligence does not contribute to IGT performance in children (Crone & van der Molen, 2004; Lehto & Elorinne, 2003). We believe that this difference may arise for the following two reasons. First, only a few child studies have examined the relationship between fluid intelligence and IGT performance, so more research may be required to confirm the results. Second, child studies used a single index of IGT performance-the number of selected advantageous cards (Crone & van der Molen, 2004; Lehto & Elorinne, 2003), whereas adult studies applied multiple indices, including indices that focused on the overall IGT performance (e.g., the overall net score and the number of selected advantageous cards) and indices that focused on the progression of the IGT performance (e.g., the net scores in each block) (e.g., Demaree et al., 2010; Fein et al., 2007; Haaland & Landrø, 2007; Johnson et al., 2006; Levine et al., 2005; Nakamura et al., 2008; Webb et al., 2014). Hence, in the present study, we use multiple indices of IGT performance (overall net score and net scores in five blocks) to explore the relationship between fluid intelligence and IGT performance in children. Simultaneously, from the perspective of individual differences, we use intellectually average and intellectually gifted children to further explore the relationship between fluid intelligence and IGT performance.

Moreover, the IGT is a paradigm that involves both emotional (implicit) and cognitive (explicit) processes (Telle, Senior, & Butler, 2011). An area of recent interest in IGT performance addresses the role of emotional intelligence (EI). The somatic marker hypothesis (SMH) supports the idea that the emotional process plays a role in IGT. The SMH postulates that the somatic marker affects decision making and that these marker signals (e.g., sensations from the internal milieu, viscera, the skeletal and smooth muscles) can help to reduce the difficulties in situations involving complexity and uncertainty in decision making (Damasio & Sutherland, 1994). The SMH has been confirmed by Bechara, Tranel, Damasio, and Damasio (1996), who measured skin conductance responses (SCRs) in patients with ventromedial prefrontal cortex (vmPFC) damage and in healthy participants. Their results showed that patients with vmPFC damage did not generate anticipatory SCRs before they selected a card, which indicated that the vmPFC damage failed to activate biasing signals that would be valuable in recognizing the distinction between choices with good or bad future outcomes (Bechara et al., 1996). A substantial number of empirical studies have explored the relationship between EI and IGT performance. Some studies have found that EI can positively predict IGT performance; specifically, people with higher EI scores made better decisions compared to those with lower EI scores (e.g., Sevdalis, Petrides, & Harvey, 2007; Telle et al., 2011). Some studies found there was a negative correlation between “surround” (a facet of EI that focuses on these three aspects: personal stress, stress in the workplace and life events) and IGT performance in female students (Sarmány-Schuller, 2009). However, other studies have found no correlation between EI and IGT performance (e.g., Demaree et al., 2010).

It's worth mentioning that previous studies that used the Trait Emotional Intelligence Questionnaire (TEIQue) to assess EI often found an EI-IGT relationship, but studies using the Emotional Intelligence Scale (EIS) to evaluate EI did not. These two EI measurements are both based on self-reports but belong to different EI models. Specifically, the EIS belongs to the ability EI model (Mayer & Salovey, 1997), while the TEIQue belongs to the trait EI model (Petrides & Furnham, 2001). Ability EI is defined as “the ability to perceive and express emotion, assimilate emotion in thought, understand and reason with emotion, and regulate emotion in the self and others” (Mayer & Salovey, 1997), while trait EI denotes a constellation of self-perceptions at the lower-order personality (Petrides & Furnham, 2001). There are differences between the ability EI model and the trait EI model. Trait EI reflects the inherent subjectivity of an individual's emotional experience and focuses on people's emotional self-perceptions, while the conceptualization of ability EI is cognitive ability (Petrides, 2011). Additionally, Webb et al. (2014) used three common measures of EI (the Mayer–Salovey–Caruso Emotional Intelligence Test (MSCEIT), the Bar-On Emotional Quotient Inventory(EQ-i),and the Self-Rated Emotional Intelligence Scale (SREIS)) to assess EI. They found that the performance-based measure of EI (MSCEIT) was significantly correlated with IGT performance, whereas neither of the self-reported measures (EQ-i and SREIS) were associated with IGT performance. It is worth exploring whether the relationship between EI and IGT is affected by subjective or objective measurement of EI. Moreover, Sevdalis et al. (2007) proposed that compared with ability EI, trait EI is more suitable as a framework for explaining the way emotions affect decision making in terms of individual differences. Consequently, we use the TEIQue-CF (a subjective trait EI measurement) in the present study to assess EI and explore its correlation with IGT performance in average and gifted children.

It is striking that only a few studies have simultaneously examined fluid intelligence and EI in predicting IGT performance. Thus far, only two studies have examined this issue, and both concentrated on healthy adults. Demaree et al. (2010) conducted six separate linear regressions to determine the unique contributions of IQ and EI on IGT performance (range of R-squared values: 0.001–0.17) and they found that fluid intelligence, not EI, could predict IGT performance, which suggests that cognitive abilities rather than emotional abilities may primarily drive performance on the IGT. Webb et al. (2014) found similar results regarding the IQ-IGT relationship by using hierarchical multiple regression analyses to test the contributions of IQ and EI in predicting IGT performance (range of R-squared values: 0.004–0.202), but they found that EI measured using performance-based measures could predict IGT performance. Additionally, Webb et al. (2014) also found that fluid intelligence had a positive relationship with EI ($r = 0.30$)—a research result similar to other substantial studies (e.g., Agnoli et al., 2012; Ciarrochi, Chan, & Caputi, 2000; Cote & Miners, 2006; Mayer, Caruso, & Salovey, 1999; Schulte, Ree, & Carretta, 2004). To date, however, no study has used child samples and simultaneously examined fluid intelligence and EI in predicting IGT performance. Thus, the present study explores the roles of fluid intelligence and EI in predicting IGT performance in children. Furthermore, we attempt to simultaneously consider intellectually average and intellectually gifted children to explore whether fluid intelligence and EI play the same roles in predicting IGT performance.

The aim of the present study is to explore the roles of fluid intelligence and EI to explain the IGT performance of both intellectually average and gifted children. We hypothesized that (1) intellectually gifted children would perform better on the IGT compared to intellectually average children of the same age and (2) that in both intellectually gifted and average children, fluid intelligence and EI would both predict IGT performance, but that IGT performance would be more closely related to fluid intelligence.

2. Method

2.1. Participants

Two groups of children divided by IQ were recruited to participate in the current study. The intellectually gifted children ($n = 98$, 54 boys and 44 girls, ages 7.78–11.49 years, mean age: 9.26 years) were recruited from a gifted educational program called the “Gifted Youth Class”. The “Gifted Youth Class” enrolls about 30 children from